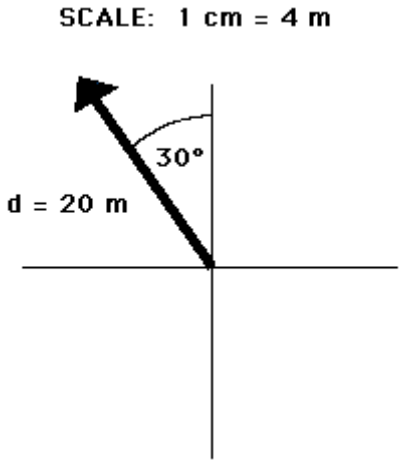
## Vectors and Direction

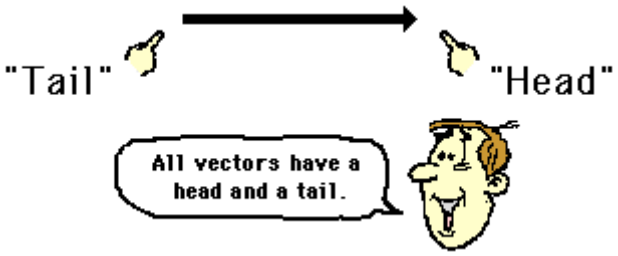
A study of motion will involve the introduction of a variety of quantities which are used to describe the physical world. Examples of such quantities include distance, displacement, speed, velocity, acceleration, force, mass, momentum, energy, work, power, etc. All these quantities can by divided into two categories - vectors and scalars. A vector quantity is a quantity which is fully described by both magnitude and direction. On the other hand, a scalar quantity is a quantity which is fully described by its magnitude. The emphasis of this unit is to understand some fundamentals about vectors and to apply the fundamentals in order to understand motion and forces which occur in two dimensions.

Examples of vector quantities include displacement, velocity, acceleration, and force. Each of these quantities is unique in that a full description of the quantity demands that both a magnitude and a direction are listed.

Vector quantities are often represented by scaled vector diagrams. Vector diagrams depict a vector by use of an arrow drawn to scale in a specific direction. Vector diagrams were introduced and used in earlier units to depict the forces acting upon an object. Such diagrams are commonly called as free-body diagrams. An example of a scaled vector diagram is shown in the diagram at the right. The vector diagram depicts a displacement vector. Observe that there are several characteristics of this diagram which make it an appropriately drawn vector diagram.

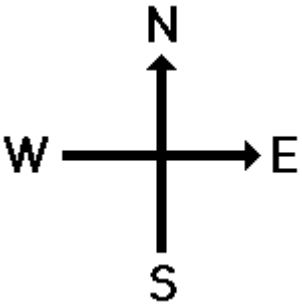


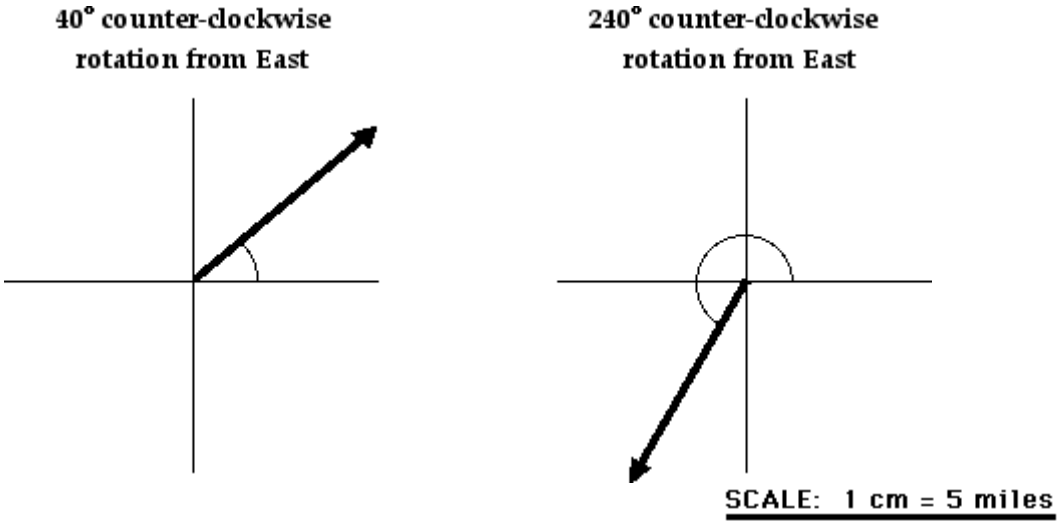

- a scale is clearly listed
- a vector arrow (with arrowhead) is drawn in a specified direction. The vector arrow has a *head* and a *tail*.
- the magnitude and direction of the vector is clearly labeled. In this case, the diagram shows the magnitude is 20 m and the direction is (30 degrees West of North).




## Conventions for Describing Directions of Vectors

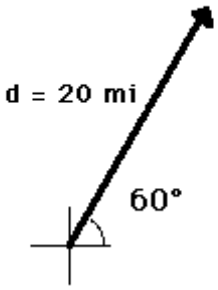
Vectors can be directed due East, due West, due South, and due North. But some vectors are directed *northeast* (at a 45 degree angle); and some vectors are even directed *northeast*, yet more north than east. Thus, there is a clear need for some form of a convention for identifying the direction of a vector which is not due East, due West, due South, or due North. There are a variety of conventions for describing the direction of any vector. The two conventions which will be discussed and used in this unit are described below:



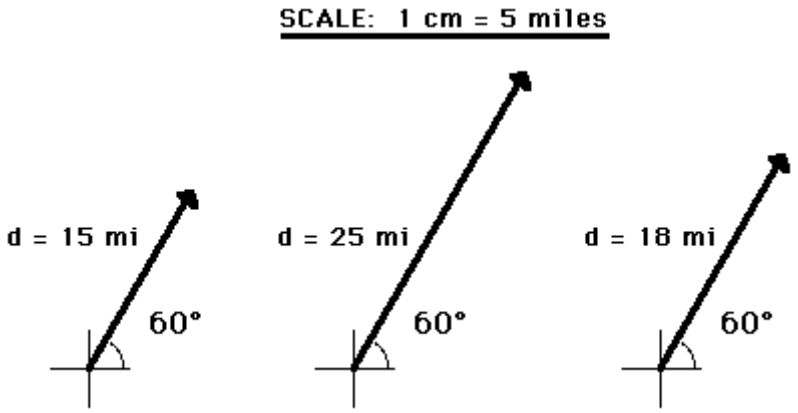



## Representing the Magnitude of a Vector

The magnitude of a vector in a scaled vector diagram is depicted by the length of the arrow. The arrow is drawn a precise length in accordance with a chosen scale. For example, the diagram at the right shows a vector with a magnitude of 20 miles. Since the scale used for constructing the diagram is 1 cm = 5 miles, the vector arrow is drawn with a length of 4 cm. That is, 4 cm x (5 miles/1 cm) = 20 miles.




Using the same scale (1 cm = 5 miles), a displacement vector which is 15 miles will be represented by a vector arrow which is 3 cm in length. Similarly, a 25 mile displacement vector is represented by a 5-cm long vector arrow. And finally, an 18 mile displacement vector is represented by a 3.6-cm long arrow. See the examples shown below.




In conclusion, vectors can be represented by use of a scaled vector diagram. On such a diagram, a vector arrow is drawn to represent the vector. The arrow has an obvious tail and arrowhead. The magnitude of a vector is represented by the length of the arrow. A scale is indicated (such as, 1 cm = 5 miles) and the arrow is drawn the proper length according to the chosen scale. The arrow points in the precise direction. Directions are described by the use of some convention. The most common convention is that the direction of a vector is the counter clockwise angle of rotation which that vector makes with respect to due East.